ALLEN
Mumbai, Maharashtra

MITOSIS

Mitosis

The process where a single cell divides resulting in generally two identical cells, each containing the same no. of chromosomes and genetic content as that of the original cell.

History

- Mitosis was first discovered in plant cells by Strasburger (1875).
- Later on, W. Flemming (1879) discovered it in animal cells. The term mitosis was coined by Flemming (1882).

Occurrence:

- The cells undergoing mitosis are called mitocytes. In plants, the mitocytes are mostly meristematic cells.
- In animals, the mitocytes are stem cells, germinal epithelium and embryonic cells.
- It also occurs during regeneration. Root tip is the best material to study mitosis.

REASONS FOR MITOSIS

There are three main reasons:

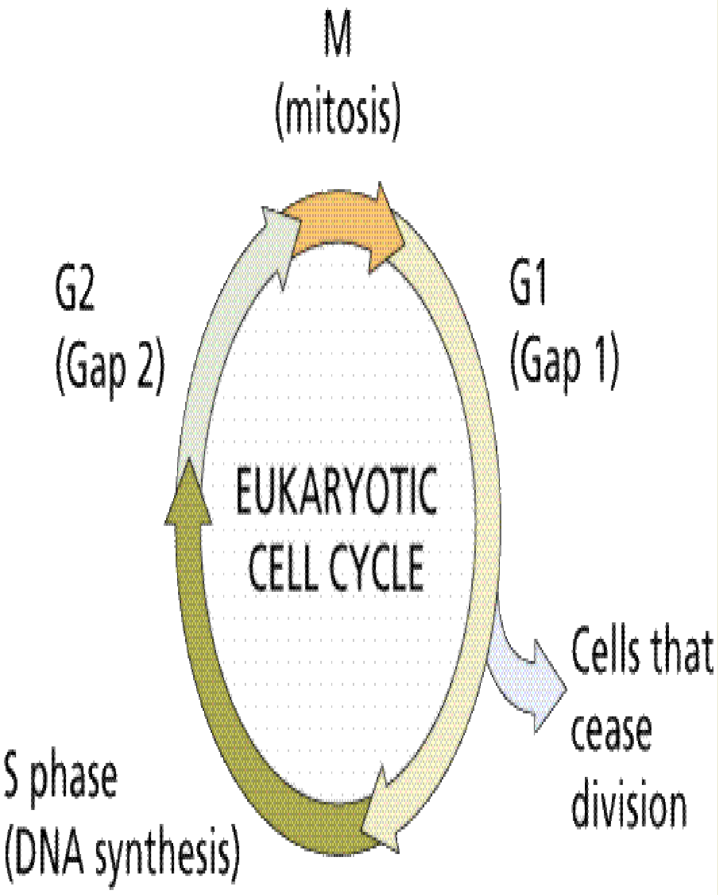
- Growth
- Repair/healing
- Asexual reproduction

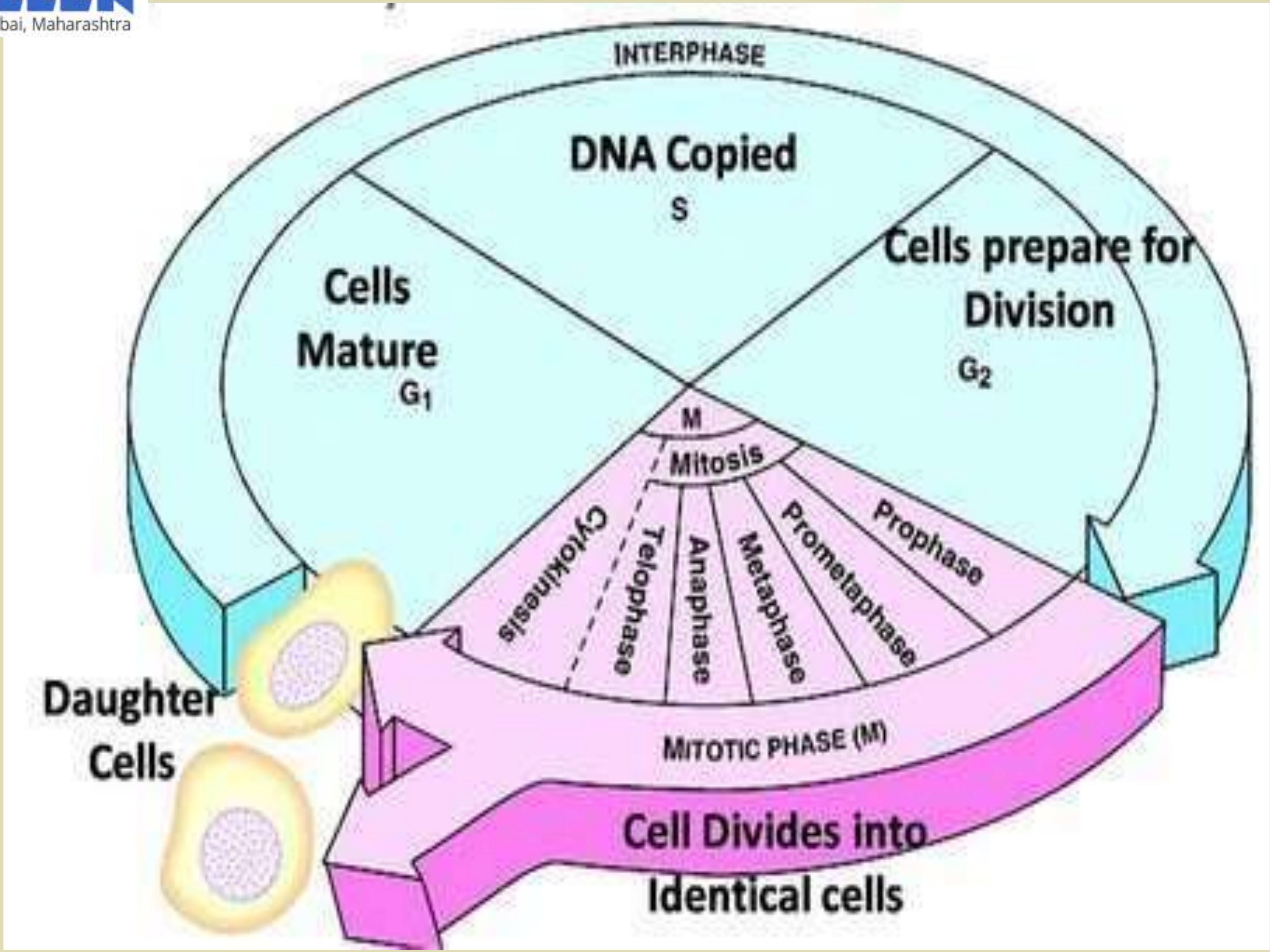
Depending on cell type

- Mitosis can take few minutes or a few days
- Muscles cells
- Nerve cells
- Skin cells
- Digestive tract cells

Cell Cycle

- A typical cell goes through a process of growth, development and reproduction called the cell cycle.
- The longest phase in the cell cycle is interphase.
- The 3 stages of interphase are called G_1, S and G_2.



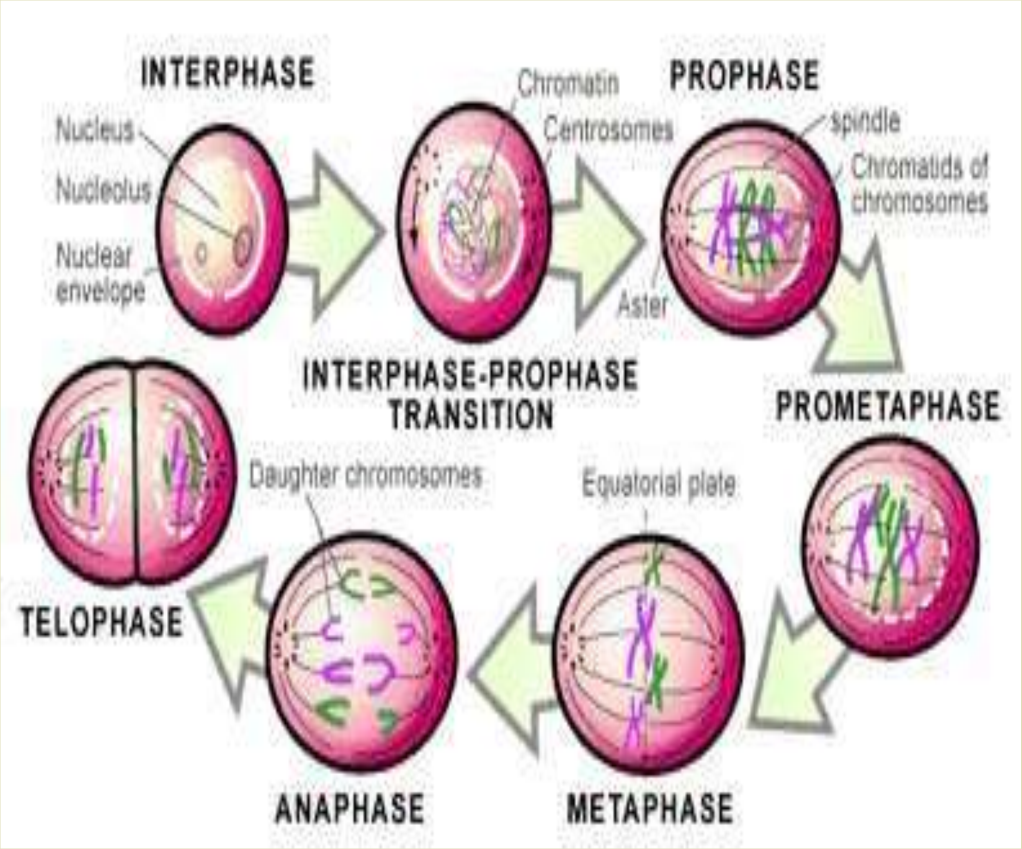

INTERPHASE
DNA Copied
S
Cells Mature
G1
Cells prepare for Division
G2
M
Mitosis
Prophase
Prometaphase
Metaphase
Anaphase
Telophase
Cytokinesis
MITOTIC PHASE (M)
Daughter Cells
Cell Divides into Identical cells

Steps of Mitosis:

- Prophase
- Prometaphase
- Metaphase
- Anaphase
- Telophase

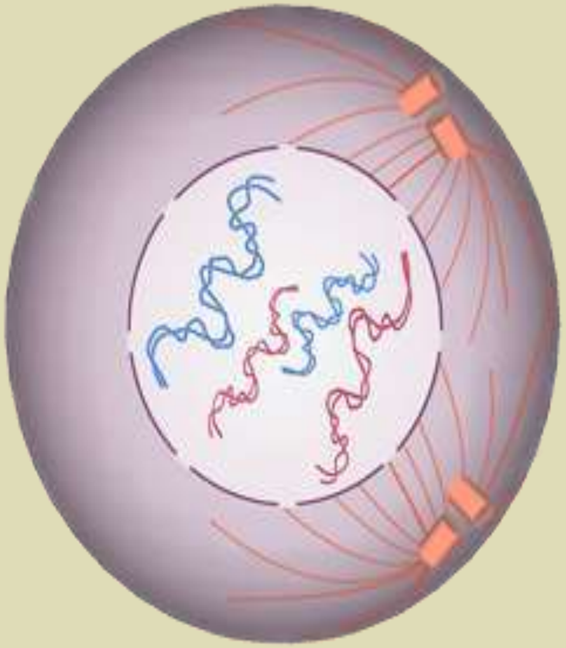
Karyokinesis

- C-Phase or Cytokinesis



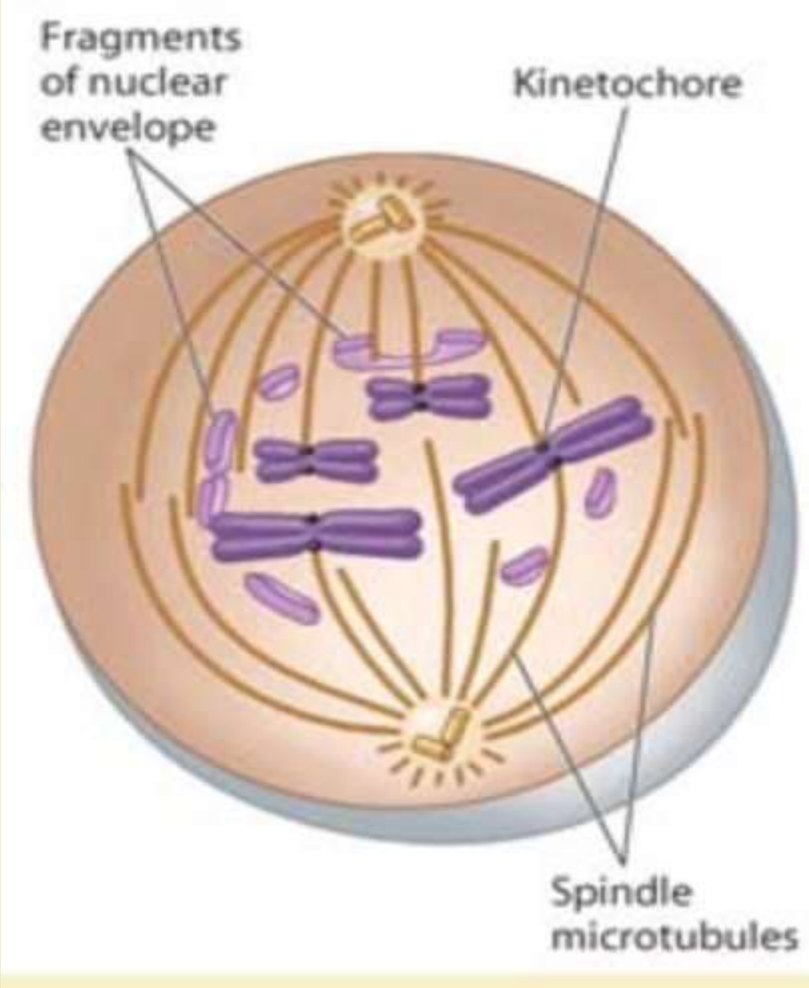
Prophase

- Nucleus becomes spherical and cytoplasm becomes more viscous.
- The chromatin slowly condenses into well-defined chromosomes.
- Each chromosomes appears as two sister chromatids joined at the centromere.
- The microtubules begins to form outside nucleus. In plants the spindle apparatus is anastral.
- In animals the mitotic spindle is amphiastral which include two asters in opposite poles of the spindle.



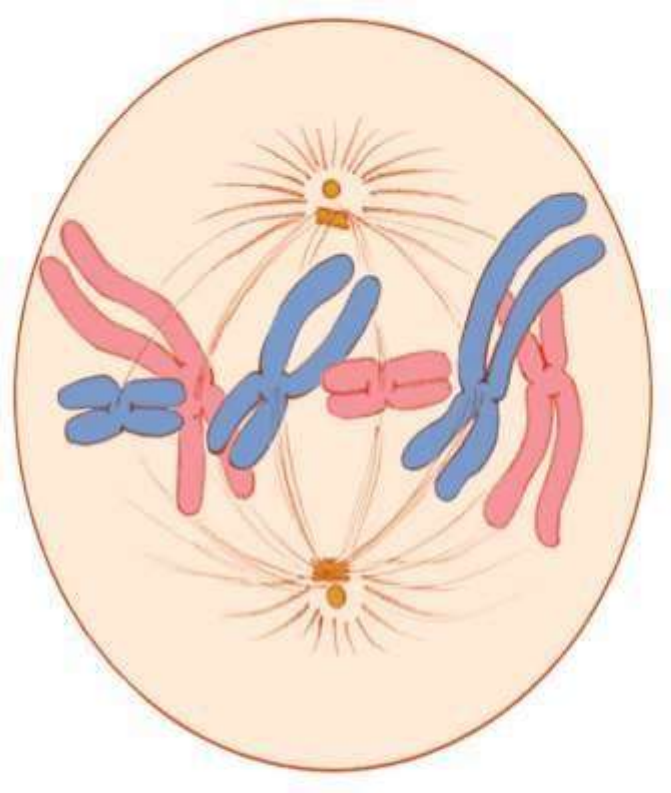
Prometaphase

- Nuclear envelop breaks down into membrane vesicles and the chromosomes set free into the cytoplasm.
- Chromosomes are attached to spindle microtubules through kinetochores.
- Nucleolus disappears.



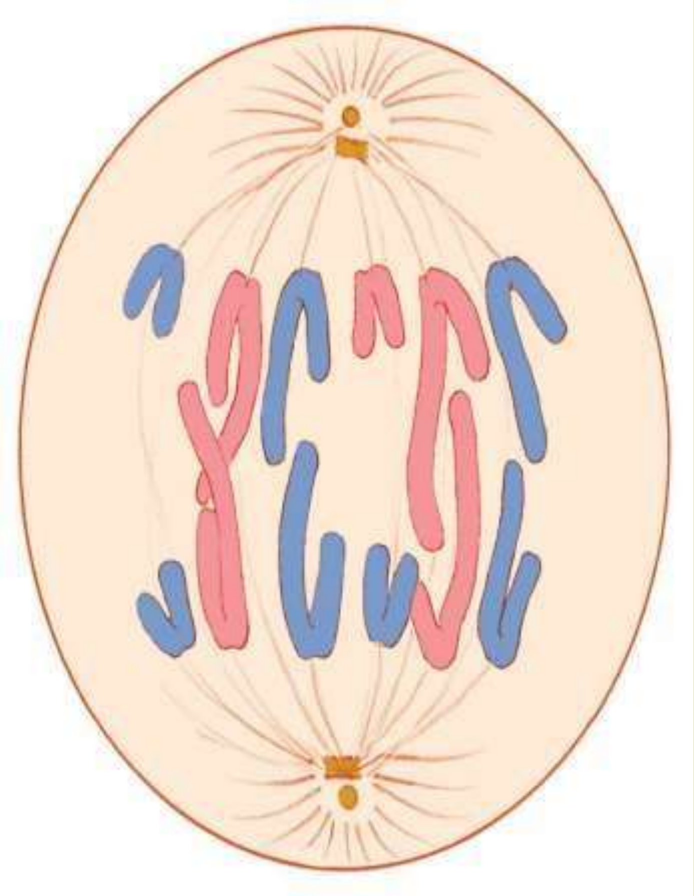
Metaphase

- Kinetochore microtubules align the chromosomes in one plane to form metaphasic plate or equitorial plate.
- Centromeres lie on the equitorial plane while the chromosome arms are directed away from the equator called autoorientation.
- Smaller chromosomes remain towards the centre while larger ones occupy the periphery.



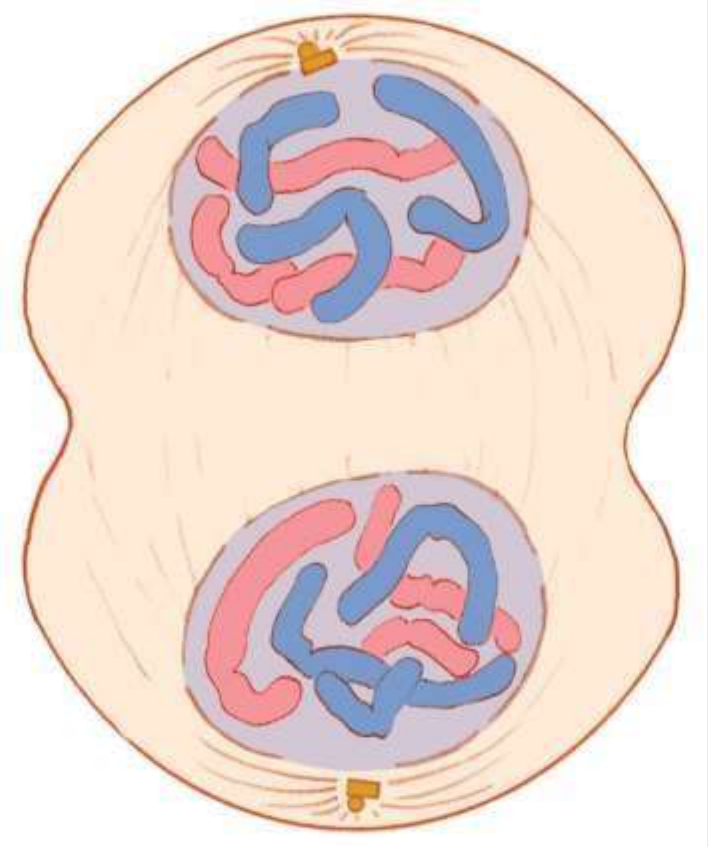
Anaphase

- Chromosomes split Simultaneously at the centromeres so that the sister chromatids separate.
- The separated sister chromatids move towards opposite poles.
- Daughter chromosomes appear V-shaped (metacentric), L-shaped (sub-metacentric), J-shaped (acrocentric), rod-shaped (telocentric)
- It is the shortest of all stages of mitosis.



Telophase

- Daughter chromosomes arrive at the poles.
- Kinetochore microtubules disappear.
- Chromosomes uncoil into chromatin.
- Nucleolus re-appears.
- It is considered as the reverse of prophase.



Cytokinesis

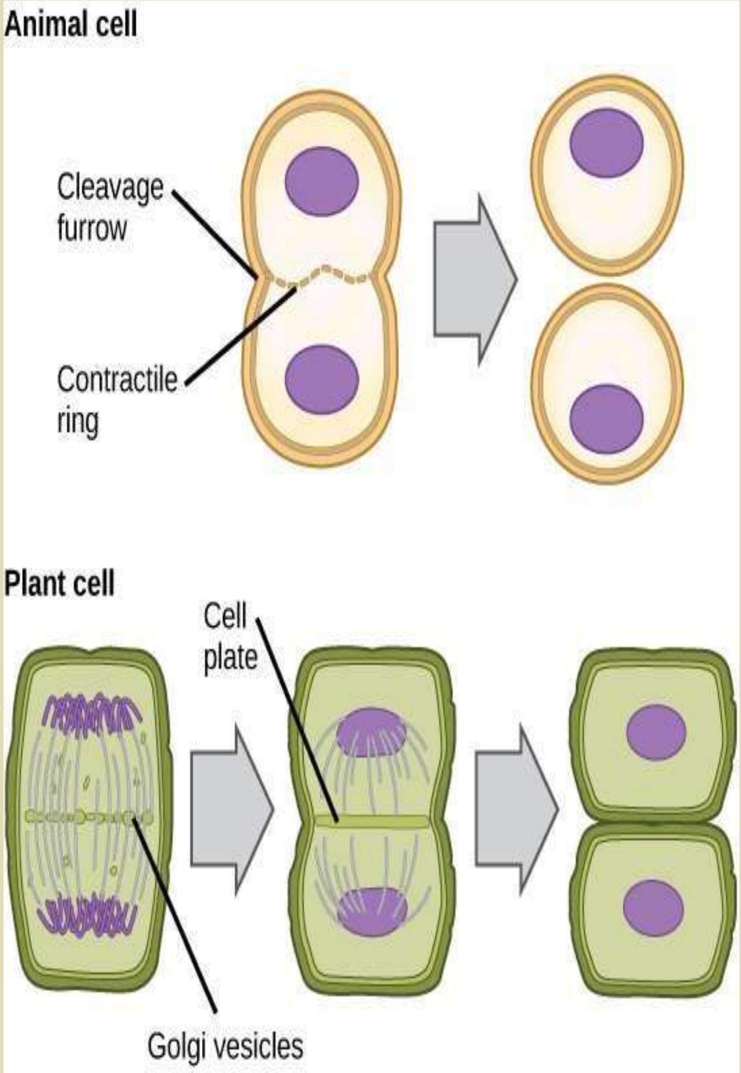
- It is the cytoplasmic division that starts during anaphase and completed by the end of telophase.
- It takes place by two different methods i.e., cell plate method and cleavage or cell furrowing method.

- ✓ Cell plate cytokinesis

It occurs in plant cells. The golgi vesicles fuse at the centre to form barrel shaped phragmoplast. The contents of phragmoplast solidify to become cell plate, which separates the two daughter cells.

- ✓ Cleavage cytokinesis

It occurs in animal cells. In this process a cleavage furrow appears at the middle, which gradually deepens and breaks the parent cell into two daughter cells.



Significance

- Mitosis is an equational division.
- It is the division through which daughter cells that are identical are produced.
- Genetic stability: It maintains constant chromosome no. and genetic stability in all somatic or vegetative cells of the body.
- Growth: Mitosis increases cell no. so that a zygote transforms into a multicellular adult.
- Surface-volume ratio: As the size of a cell increases, the surface area decreases accordingly. By mitosis, the cell becomes smaller in size and the surface volume ratio is restored.

Animal Vs Plant Mitosis

- Animal Cell
  - ✓ Centriole and aster present.
  - ✓ Daughter cells separated by cleavage furrow.

- Plant cell
  - ✓ No visible centriole or ester.
  - ✓ Daughter cells separated by cell plate

Conclusion

Mitosis is one of the important part of the growth and development process in both animals and plants. In plants, the cells that are dividing because of mitosis are usually found on the meristems, the tips of roots and shoots.

However, in animals, the diving cells can happen in any tissue that is growing, but the dividing cells are mostly found in dividing embryos, mainly the blastulas.

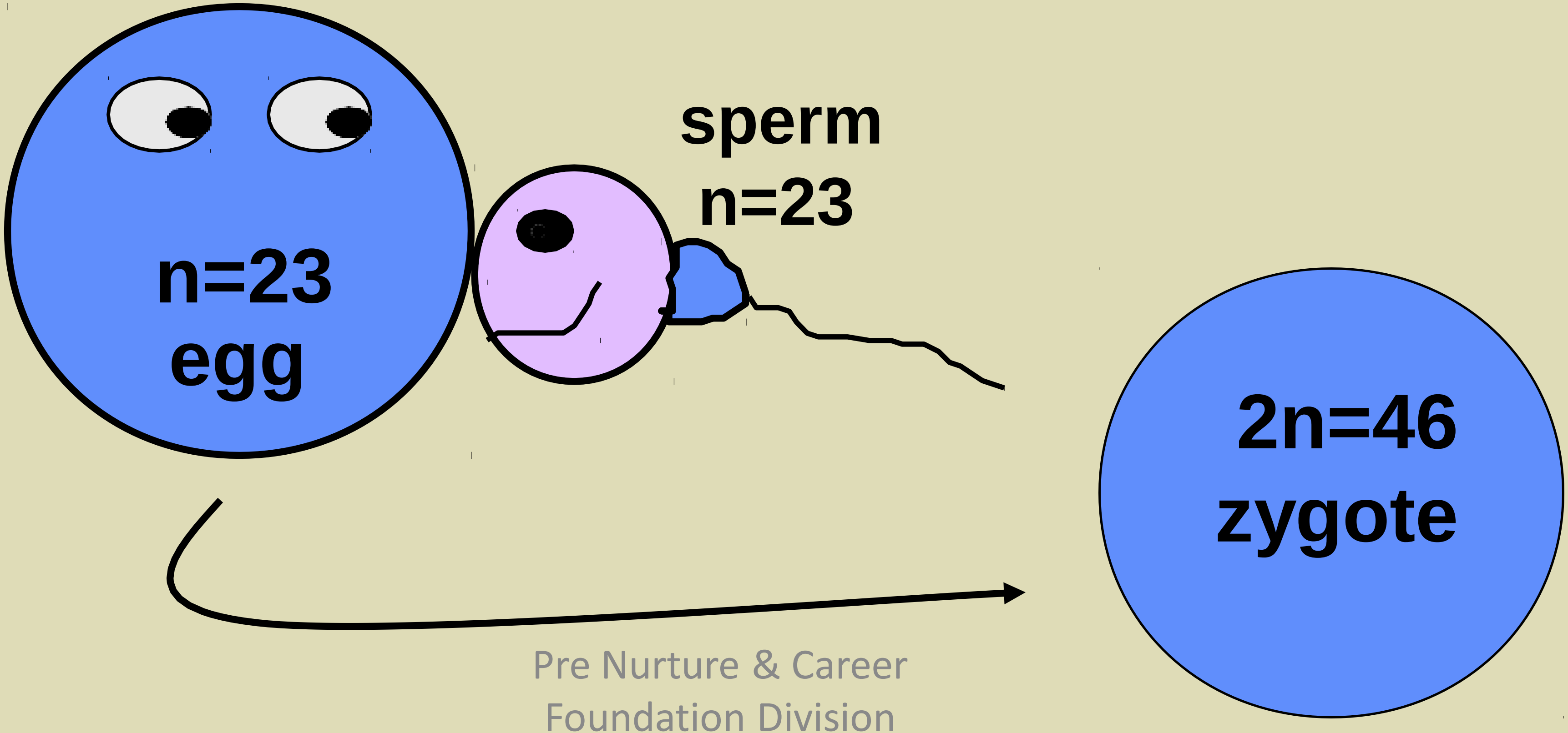
It also makes it possible for tissues to repair i.e., healing when we get hurt. For this to happen, mitosis maintains the same genetic makeup in both daughter cells.

Meiosis

- The form of **cell division** by which **gametes,** with **half** the number of **chromosomes,** are produced.
- **Diploid (2n) → haploid (n)**
- **Meiosis** is **sexual reproduction.**
- **Two divisions** (**meiosis I** and **meiosis II**).

Fertilization

- The fusion of a **sperm** and **egg** to form a **zygote**.
- A zygote is a fertilized egg



n=23
egg

sperm
n=23

2n=46
zygote

Meiosis

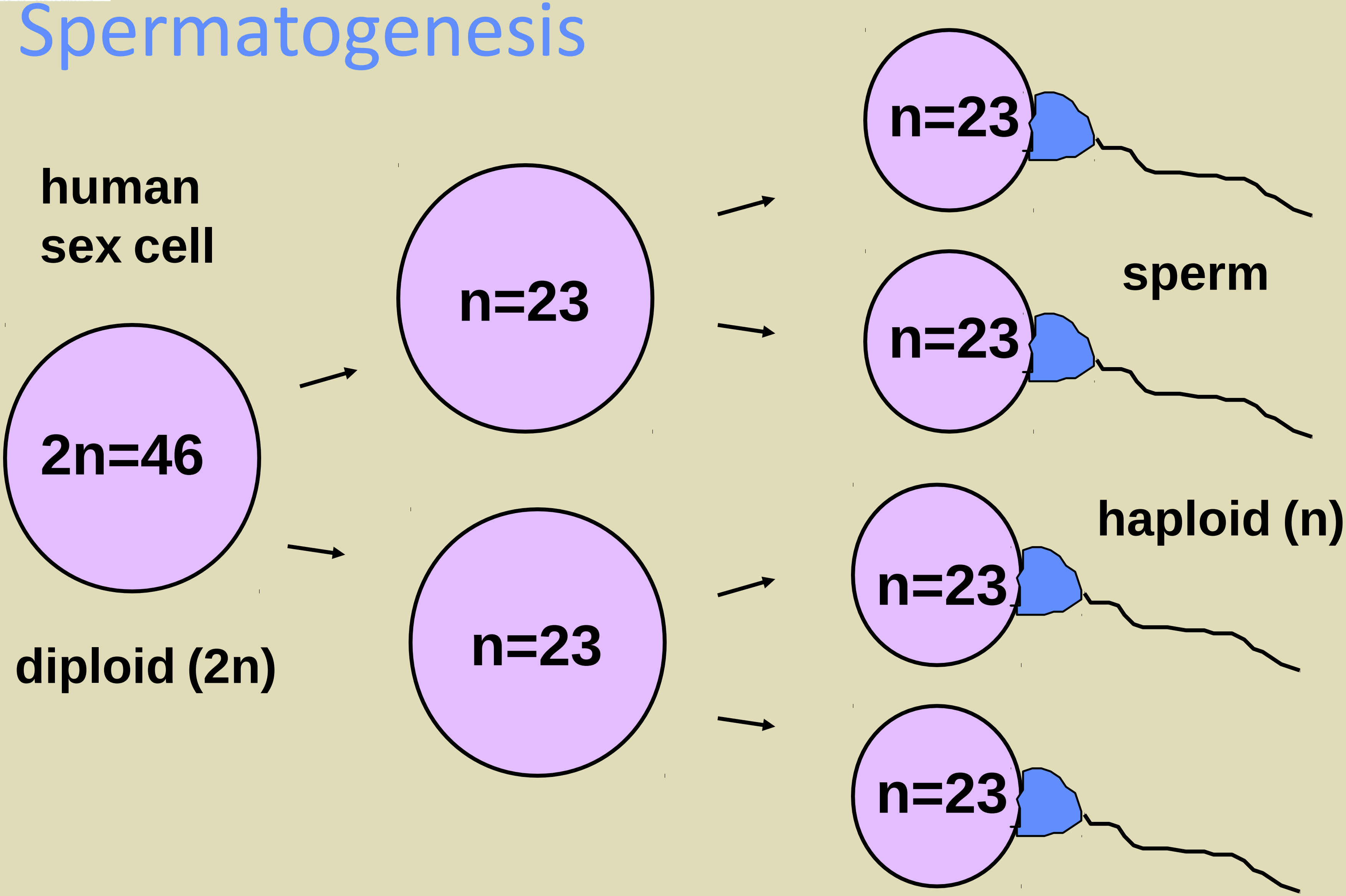
- **Sex cells** divide to produce **gametes (sperm or egg)**.
- **Gametes** have **half** the # of **chromosomes**.
- **Occurs only in gonads (testes or ovaries).**

Male: spermatogenesis

Female: oogenesis

- **Meiosis** is similar to **mitosis** with some chromosomal differences.

Spermatogenesis



human
sex cell

2n=46

diploid (2n)

n=23

n=23

n=23

n=23

n=23

n=23

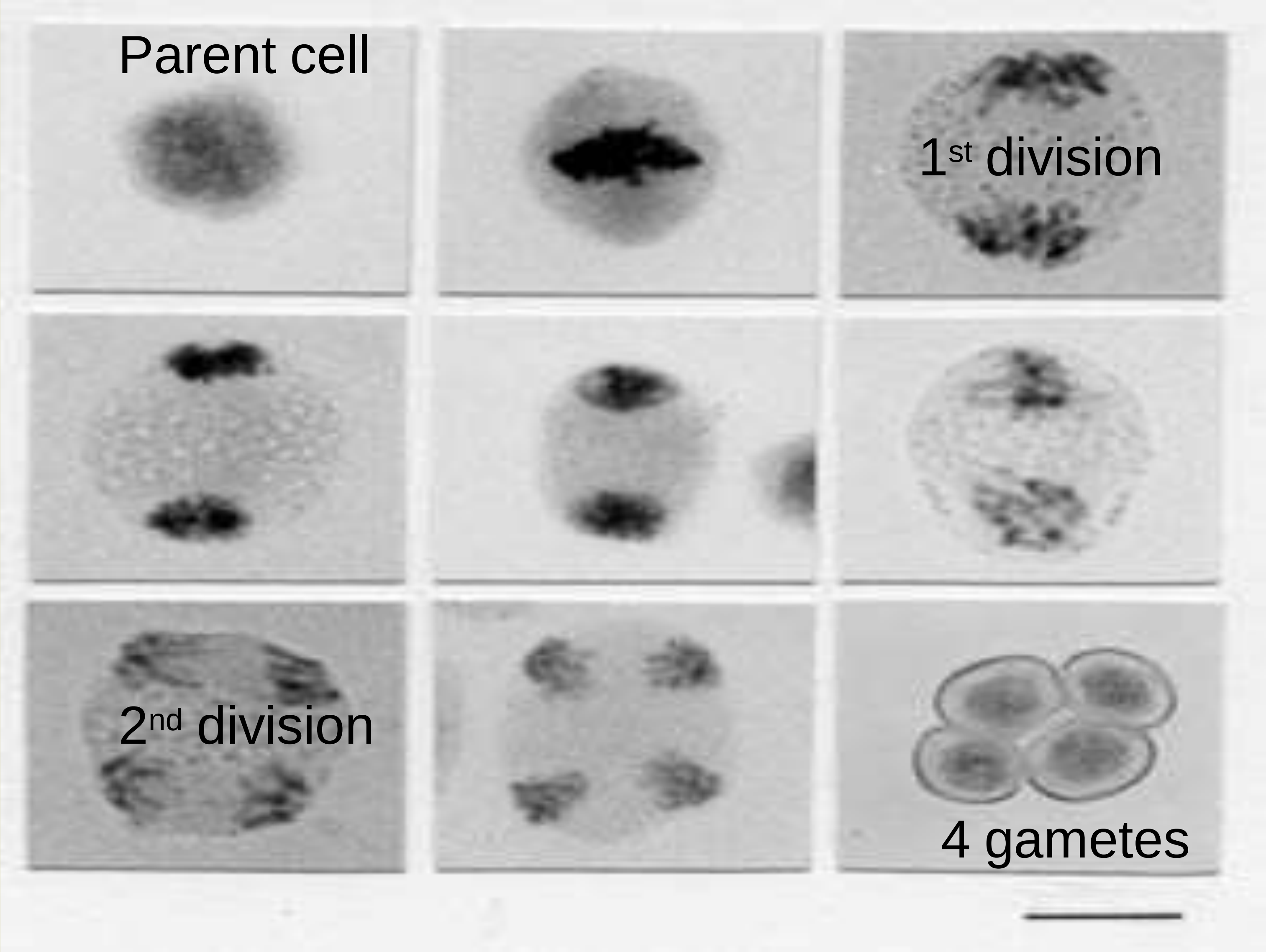
sperm

haploid (n)

meiosis I

meiosis II

Meiosis – mouse testes

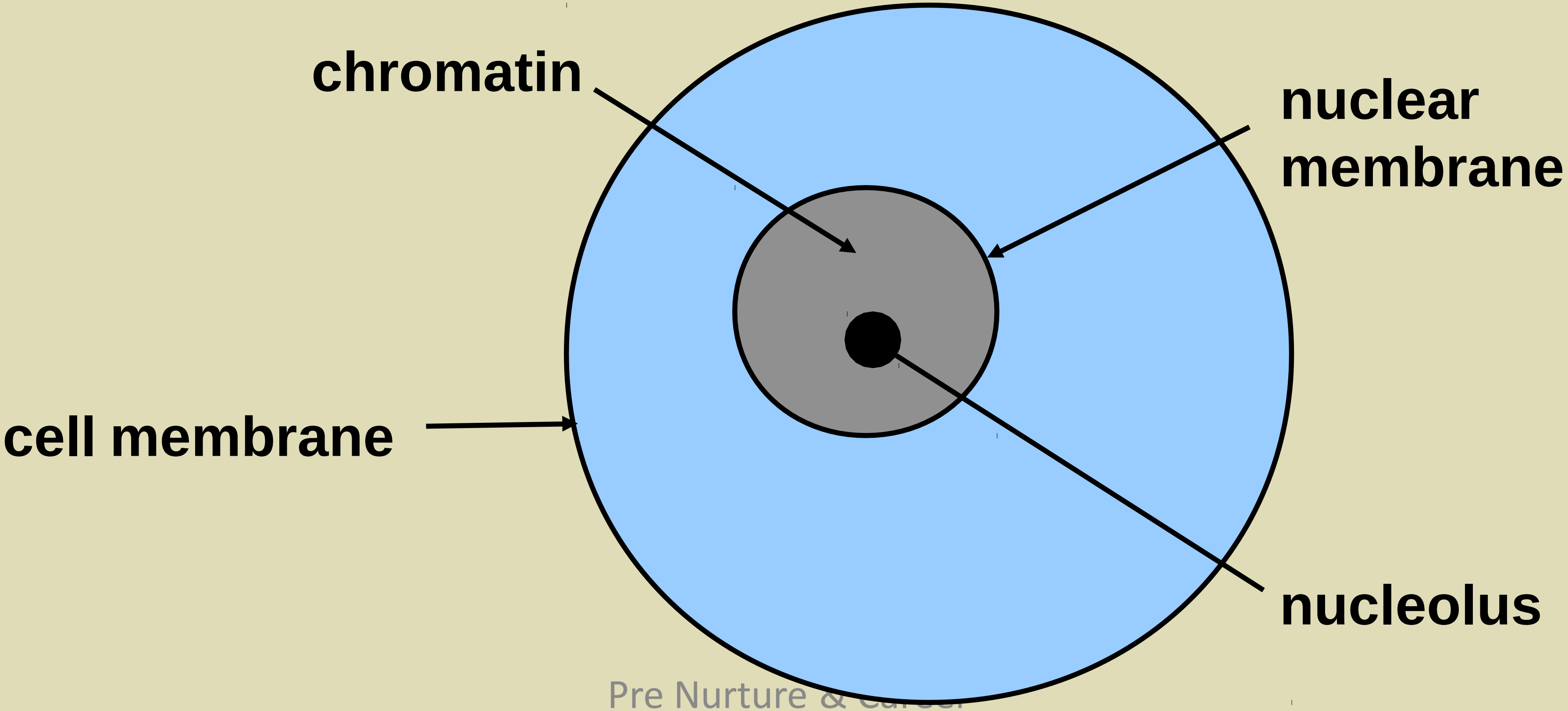


Interphase I

- Similar to **mitosis** interphase.
- **Chromosomes** replicate **(S phase).**
- Each duplicated **chromosome** consist of two identical sister **chromatids** attached at their **centromeres**.
- **Centriole** pairs also replicate.

Interphase I

- **Nucleus** and **nucleolus** visible.



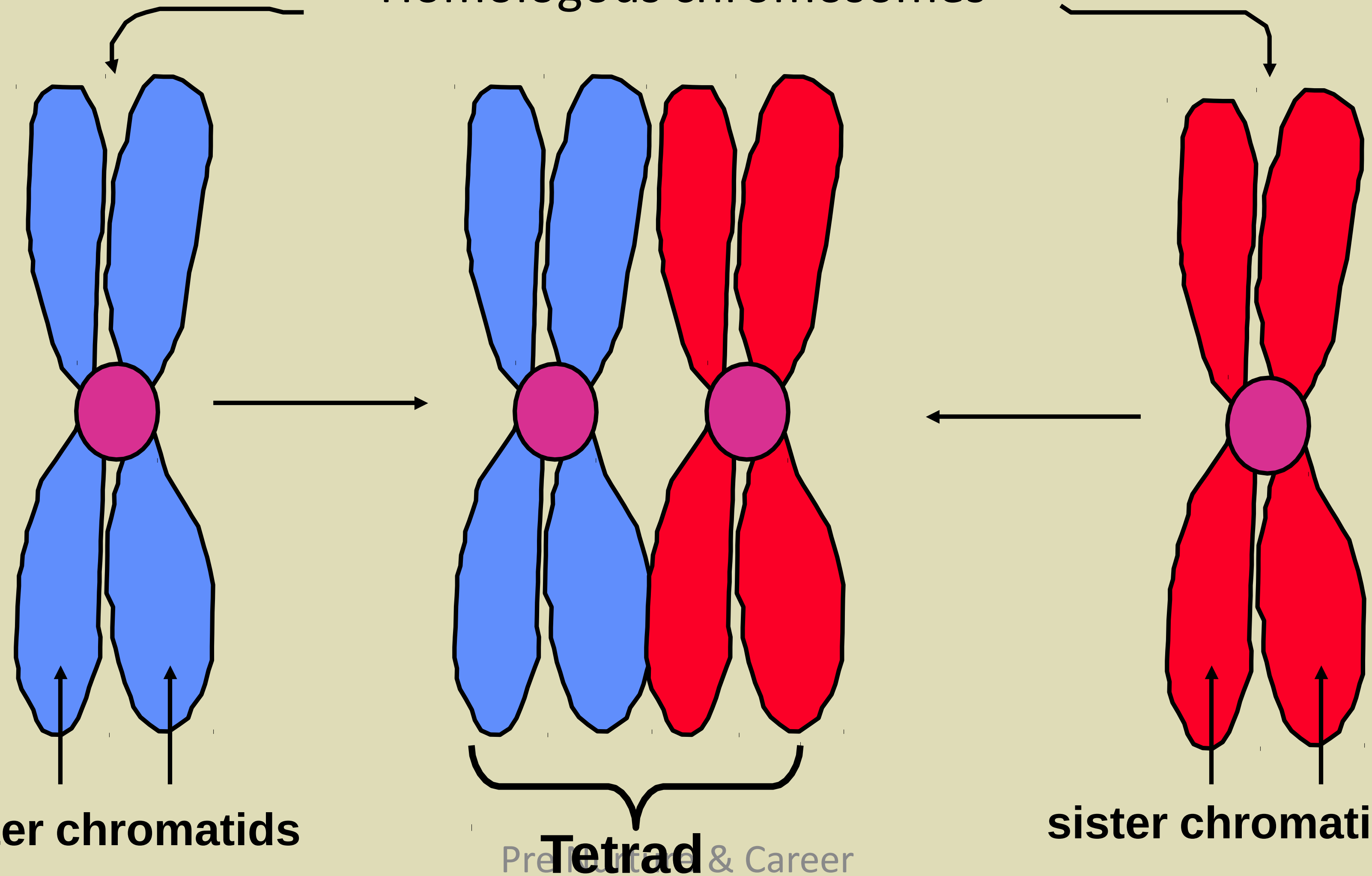
Meiosis I (four phases)

- **Cell division** that reduces the **chromosome** number by **one-half.**
- **four phases**:
  a. **prophase I**
  b. **metaphase I**
  c. **anaphase I**
  d. **telophase I**

Prophase I

- **Longest and most complex phase (90%).**
- **Chromosomes** condense.
- **Synapsis** occurs: **homologous chromosomes** come together to form a **tetrad**.
- **Tetrad** is two **chromosomes** or four **chromatids** (sister and nonsister chromatids).

Prophase I -Synapsis



Homologous chromosomes

sister chromatids

Tetrad

sister chromatids

Homologous Chromosomes

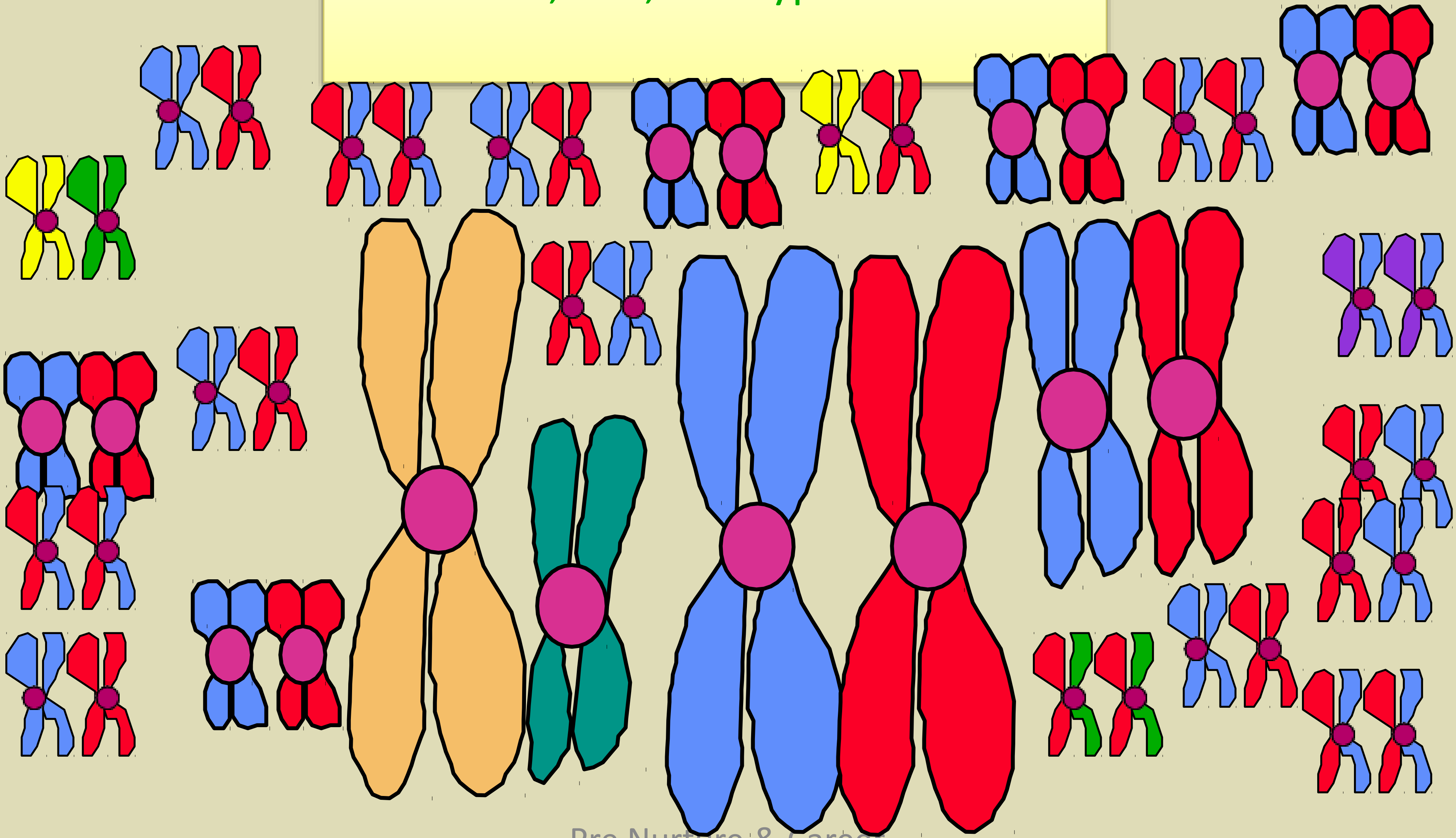
- **Pair of chromosomes (maternal and paternal) that are similar in shape and size.**
- **Homologous pairs (tetrads) carry genes controlling the same inherited traits.**
- **Each locus (position of a gene) is in the same position on homologues.**
- **Humans have 23 pairs of homologous chromosomes.**

a. 22 pairs of autosomes
b. 01 pair of sex chromosomes

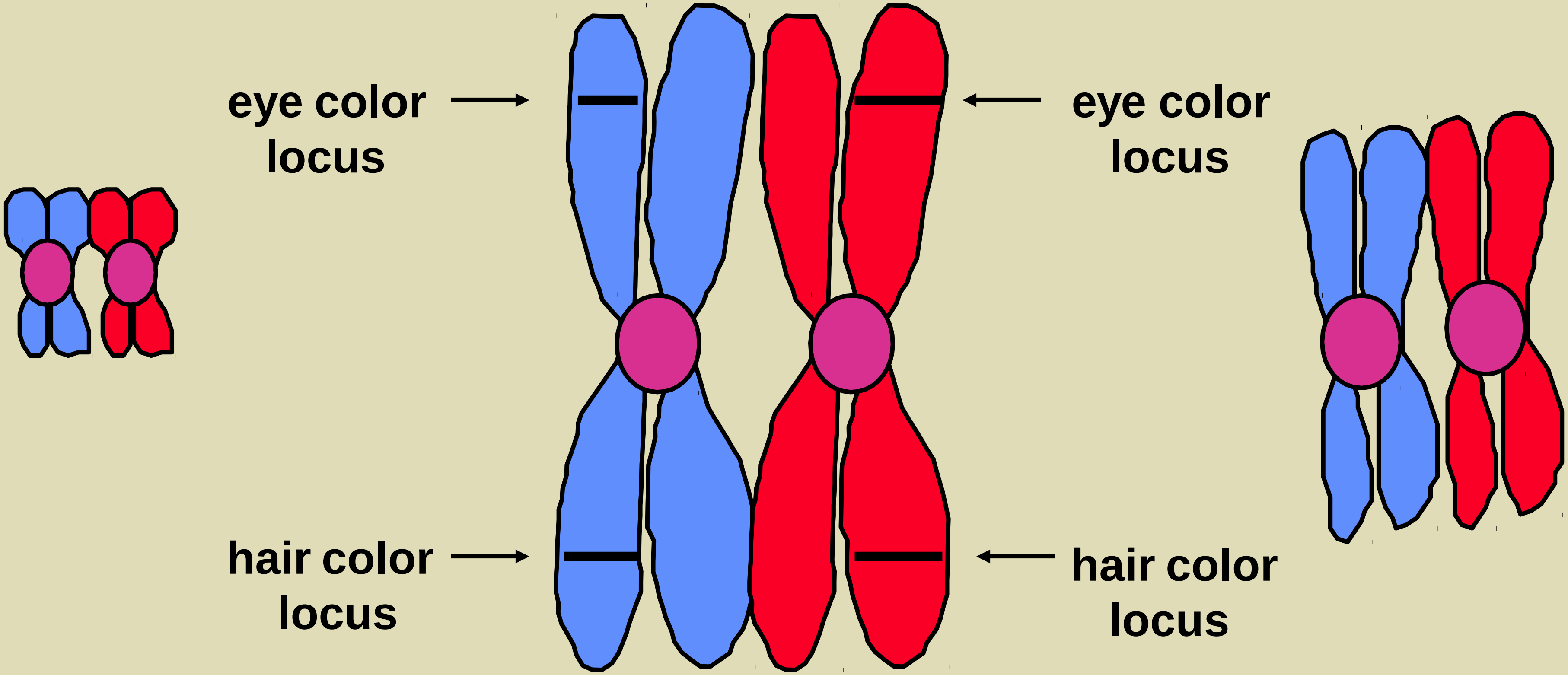
Karyotype

An Assignment on

- A method of organizing the chromosomes of a cell in relation to number, size, and type.



Homologous Chromosomes



eye color locus

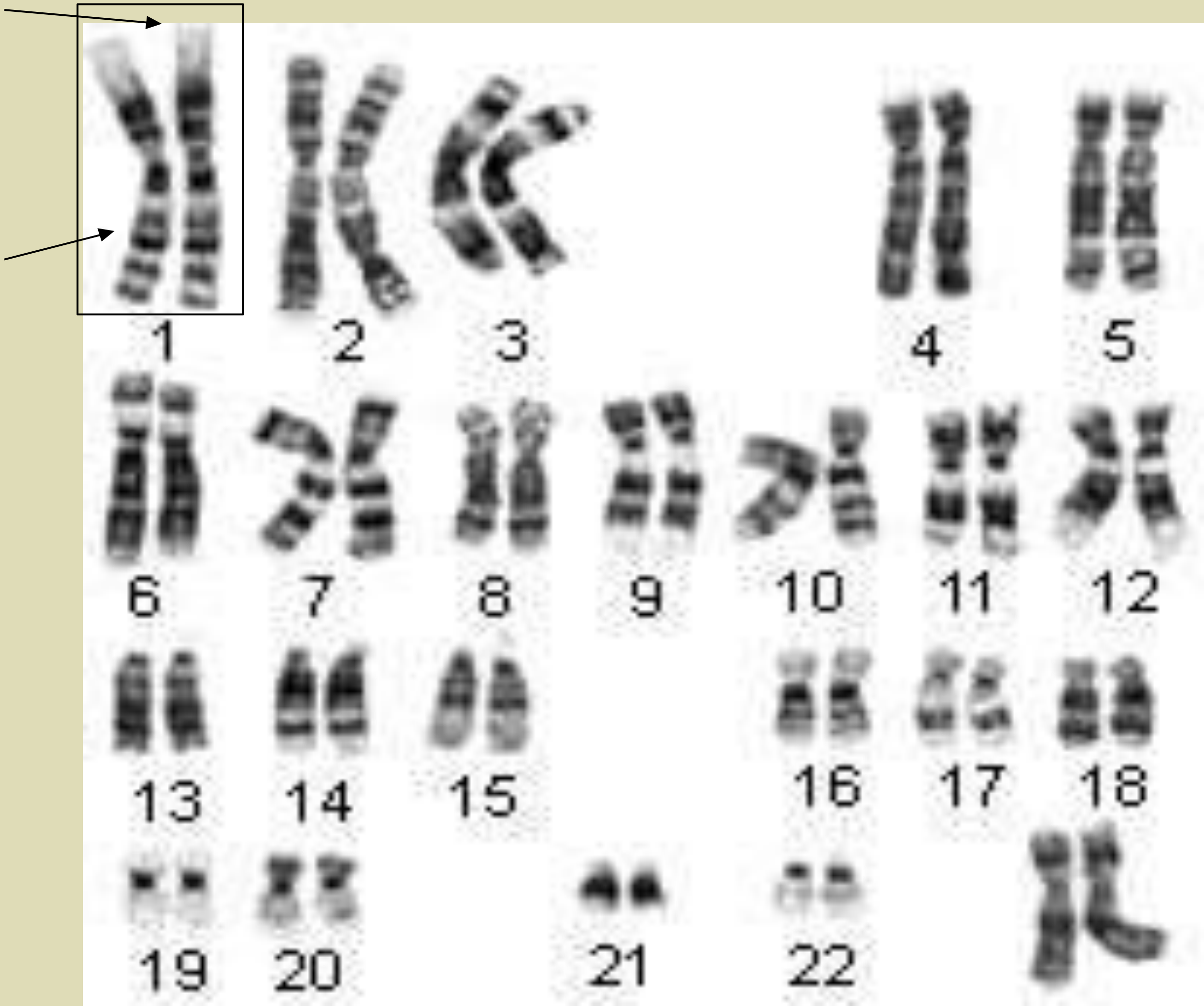
hair color locus

eye color locus

hair color locus

Paternal **Maternal**

Humans have 23 Sets of Homologous Chromosomes Each Homologous set is made up of 2 Homologues.

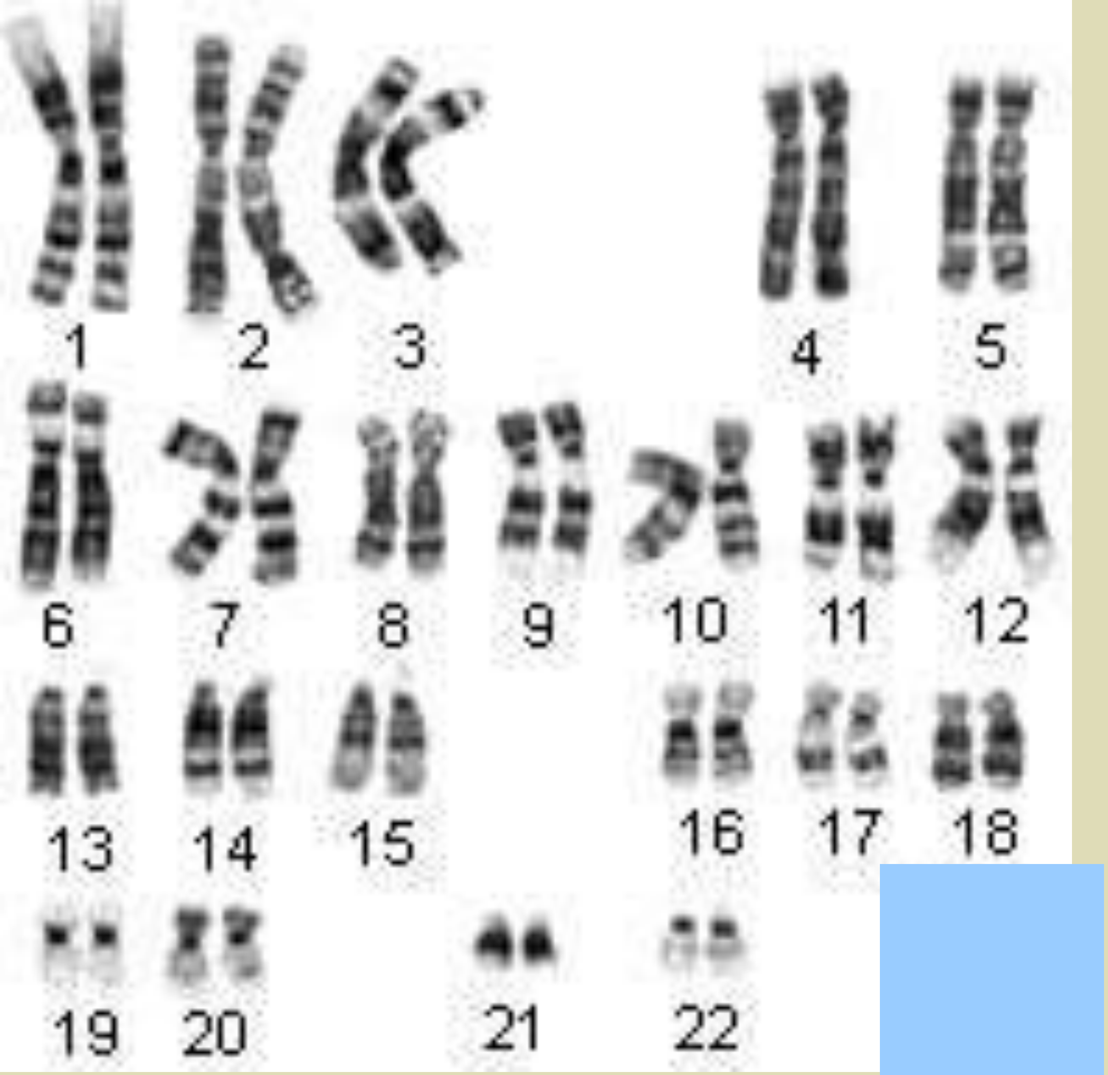


Homologue

Homologue

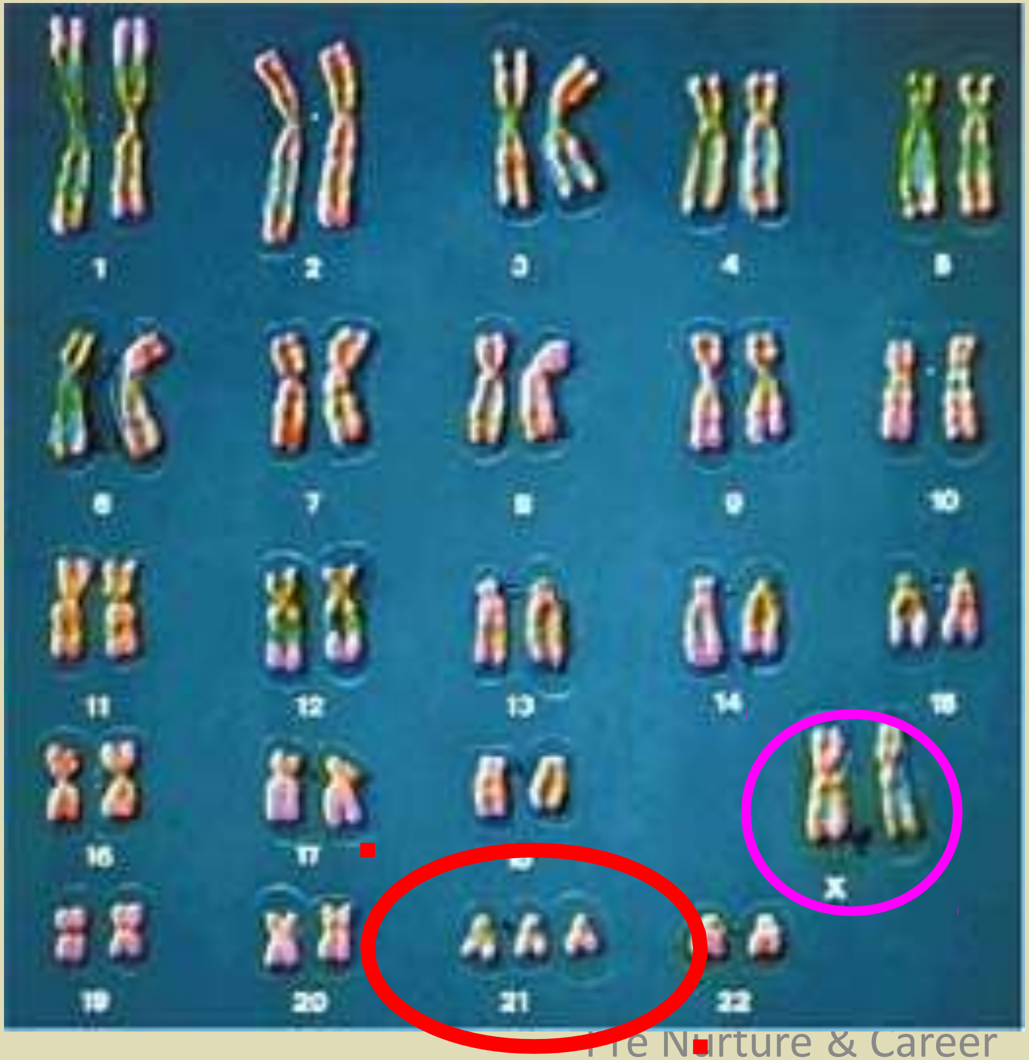
In Humans the “Autosomes” are sets 1 - 22

(The Autosome



21 trisomy – Downs Syndrome

Animal Vs Plant Mitosis

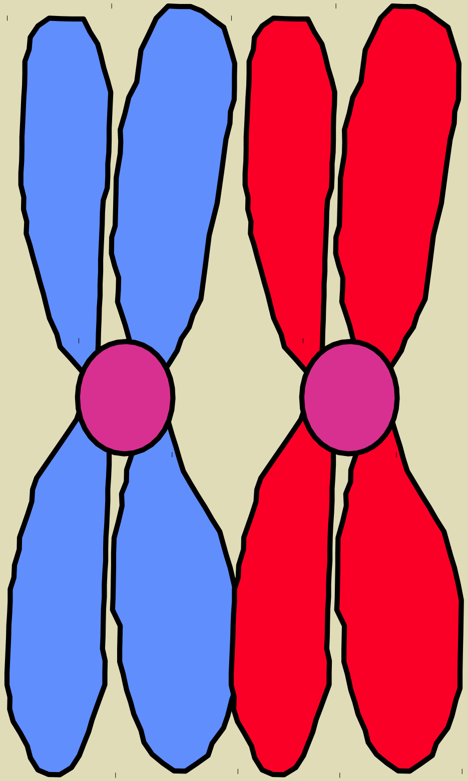


Can you see the extra 21st chromosome?

Is this person male or female?

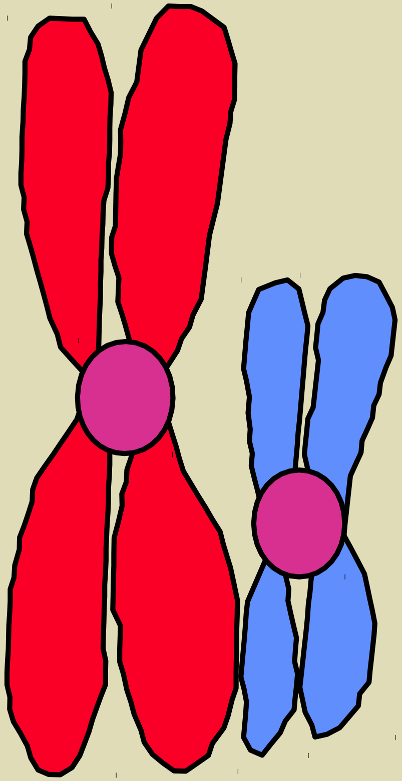
Sex Chromosomes

The Sex Chromosomes code for the sex of the offspring.
**** If the offspring has two “X” chromosomes it will be a female.**
**** If the offspring has one “X” chromosome and one “Y” chromosome it will be a male.**



XX chromosome - female

In Humans the “Sex Chromosomes” are the 23rd set



XY chromosome - male

oy or Girl? The Y Chromosome “Decides”